1   WHAT IS CLAIMED IS:

SUB A₂

1. A method comprising contacting at least an alkane having from 2 to 4 carbon atoms to a catalyst comprising at least nickel oxide and dehydrogenating said alkane with a selectivity

3   of greater than 70% and a conversion of greater than 10%.

1   2. The method of claim 1 wherein said selectivity is greater than 75%.

1   3. The method of claim 2 wherein said selectivity is greater than 80%.

1   4. The method of claim 3 wherein said selectivity is greater than 85%.

SUB A₃   5. The method of claim 1 wherein said conversion is greater that 15%.

1   6. A process for the oxidative dehydrogenation of an alkane having from 2 to 4 carbon

SUB A₃ 2   atoms comprising contacting said alkane in the presence of oxygen to a compound comprising

3   nickel oxide and obtaining a selectivity in said dehydrogenation of greater than 70% and a

4   conversion of greater than 10%.

7. The method of claim 6 wherein said selectivity is greater than 75%.

8. The method of claim 7 wherein said selectivity is greater than 80%.

1   9. The method of claim 8 wherein said selectivity is greater than 85%.

SUB A₄

1   10. The method of claim 6 wherein said conversion is greater that 15%.

11. A process for the oxidative dehydrogenation of an alkane having from 2 to 4 carbon

2   atoms comprising

3   contacting a gas mixture comprising said alkane and oxygen to a nickel oxide containing

4   catalyst; and

5   obtaining a selectivity greater than 70% and a conversion greater 10%.

12. The method of claim 11 wherein said selectivity is greater than 75%.

1   13. The method of claim 12 wherein said selectivity is greater than 80%.

1   14. The method of claim 13 wherein said selectivity is greater than 85%.

SUB As.   15. The method of claim 11 wherein said conversion is greater that 15%.

1   16. A method for the oxidative dehydrogenation of an alkane having from 2 to 4 carbon

2   atoms comprising contacting said alkane in the presence of oxygen to a material having the

3   empirical formula

4      $Ni_xNb_yTa_zO_i$
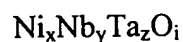
5   wherein x is in the range of about 0.05-0.96, y is in the range of from about 0-0.8, z is in

6   the range of from 0-0.8 and i is a number that satisfies valence requirements; and the sum of y

7   and z is at least 0.1.

1   17. The method of claim 16, wherein x is in the range of from about 0.4 to 0.96.

1   18. The method of claim 16 wherein x is greater than 0.5.

1   19. The method of claim 16 wherein y and z are each greater than zero and wherein the

2   sum of y and z is smaller than 0.6.

1   20. A method for the oxidative dehydrogenation of an alkane having from 2 to 4 carbon

2   atoms comprising contacting said alkane in the presence of oxygen to a material having the

3   empirical formula

4      $Ni_xA_jB_kC_lO_i$

5   wherein Ni is nickel and x is in the range of about 0.05-0.96;

6   A is a metal selected from the group consisting of Co, Nb, Ta and combinations thereof

7   and j is in the range of from about 0-0.8;

8   B is a dopant selected from the group consisting of Li, Na, K, Rb, Cs, Mg, Ca, Sr, Ba,

9   Mn, La, Ce, Pr, Nd, Sm and combinations thereof and k is in the range of from 0-0.5;

10   C is a dopant selected from the group consisting of Sn, Al, Fe, Si, B, Sb, Tl, In, Ge, Cr,

11   Pb and combinations thereof and l is in the range of from 0-0.5

12   i is a number that satisfies the valence requirements of the other elements present; and

13   the sum of j, k and l is at least 0.1.

1   21. The method of claim 20, wherein x is in the range of from about 0.5 to 0.85.

1   22. The method of claim 20 wherein x is greater than 0.1.

1   23. The method of claim 20 wherein j, k and l are each greater than zero and wherein the

2 sum of j, k and l is smaller than 0.8.

1   24. A method of making a C_2-C_4 olefin comprising the step of contacting a gas mixture

2 with a catalyst having an empirical formula:

$$Ni_aCo_bNb_cTa_dSn_eK_fAl_gFe_hO_i;$$

4   wherein b, c and d are numbers greater than or equal to zero, but less than one, and at

5 least one of b, c and d is nonzero;

6   e and f are numbers greater than or equal to zero, but less than or equal to 0.35;

7   g and h are numbers greater than or equal to zero, but less than or equal to 0.10;

8   a is a number greater than zero, but less than one, and satisfies:

9        $$a \le 1 - b - c - d - e - f - g - h;$$

10   i is a number that satisfies valence requirements; and

11   the gas mixture comprises a C_2-C_4 alkane and oxygen.

1   25. The method of claim 24, wherein:

2   c is greater than or equal to 0.10, but less than or equal to 0.85; and

3   b, d, e, f, g, and h equal zero.

1   26. The method of claim 25, wherein c is greater than or equal to 0.12, but less than or

2 equal to 0.42.

1   27. The method of claim 26, wherein c is greater than or equal to 0.14, but less than or

2 equal to 0.25.

1   28. The method of claim 25, wherein c is greater than or equal to 0.20, but less than or

2   equal to 0.50.

1   29. The method of claim 28, wherein c is greater than or equal to 0.31, but less than or

2   equal to 0.41.

1   30. The method of claim 24, wherein:

2   d is greater than or equal to 0.10, but less than or equal to 0.60; and

3   b, c, e, f, g, and h equal zero.

1   31. The method of claim 30, wherein d is greater than or equal to 0.19, but less than or

2   equal to 0.50.

1   32. The method of claim 30, wherein d is greater than or equal to 0.14, but less than or

2   equal to 0.25.

1   33. The method of claim 24, wherein:

2   b is greater than or equal to 0, but less than or equal to 0.20;

3   c is greater than or equal to 0, but less than or equal to 0.80; and

4   d, e, f, g and h equal zero.

1   34. The method of claim 33, wherein b is greater than or equal to 0.001, but less than or

2   equal to 0.20; and c is greater than or equal to 0.02, but less than or equal to 0.56.

1   35. The method of claim 33, wherein b is greater than or equal to 0, but less than or equal

2   to 0.30; and c is greater than or equal to 0, but less than or equal to 0.45.

1   36. The method of claim 35, wherein a is greater than or equal to 0.55, but less than or

2   equal to 0.85.

1   37. The method of claim 33, wherein:

2   b is greater than or equal to 0, but less than or equal to 0.33; and

3   c is greater than or equal to 0, but less than or equal to 0.52.

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38. The method of claim 37, wherein:

b is less than or equal to 0.10; and

c is greater than or equal to 0.20, but less than or equal to 0.50.

39. The method of claim 37, wherein:

b is less than or equal to 0.03; and

c is less than or equal to 0.50.

40. The method of claim 39, wherein c is greater than or equal to 0.15, but less than or equal to 0.26.

41. The method of claim 37, wherein:

b is greater than or equal to 0.001, but less than or equal to 0.19; and

c is greater than or equal to 0.13, but less than or equal to 0.33.

42. The method of claim 41, wherein c is less than or equal to 0.23.

43. The method of claim 24, wherein:

c is greater than or equal to 0, but less than or equal to 0.50;

d is greater than or equal to 0, but less than or equal to 0.50; and

b, e, f, g and h equal zero.

44. The method of claim 43, wherein:

c is greater than or equal to 0.03, but less than or equal to 0.40; and

d is greater than or equal to 0.02, but less than or equal to 0.29.

45. The method of claim 43, wherein:

a is greater than or equal to 0.46, but less than or equal to 0.96;

c is greater than or equal to 0.04, but less than or equal to 0.44; and

d is greater than or equal to 0.04, but less than or equal to 0.44.

46. The method of claim 45, wherein:

a is greater than or equal to 0.54, but less than or equal to 0.72;

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3   c is greater than or equal to 0.04, but less than or equal to 0.38; and

4   d is greater than or equal to 0.04, but less than or equal to 0.40.

1   47. The method of claim 46, wherein:

2   a is less than or equal to 0.65;

3   c is less than or equal to 0.20; and

4   d is greater than or equal to 0.15.

1   48. The method of claim 24, wherein:

2   c, d and e are each greater than or equal to 0, but less than or equal to 0.35; and

3   b, f, g and h equal zero.

1   49. The method of claim 24, wherein:

2   c, d and f are each greater than or equal to 0, but less than or equal to 0.35; and

3   b, e, g and h equal zero.

1   50. The method of claim 46, wherein:

2   a is greater than or equal to 0.58, but less than or equal to 0.64;

3   c is greater than or equal to 0.06, but less than or equal to 0.38;

4   d is greater than or equal to 0.04, but less than or equal to 0.30; and

5   f is less than or equal to 0.26.

1   51. The method of claim 47, wherein:

2   a is greater than or equal to 0.55, but less than or equal to 0.65;

3   c is greater than or equal to 0.30, but less than or equal to 0.40; and

4   b, d, e, and f equal zero.

1   52. The method of claim 51, wherein:

2   a is greater than or equal to 0.58, but less than or equal to 0.61;

3   c is greater than or equal to 0.35, but less than or equal to 0.36;

4   g is greater than or equal to 0, but less than or equal to 0.05; and

5   h is greater than or equal to 0, but less than or equal to 0.07.

1   53. The method of claim 24, wherein the gas mixture further comprises a material

2   selected from the group consisting of ethylene, butylenes or raffinate II.

1   54. The method of claim 24, wherein said contacting is carried out at a temperature of

2   about 400°C or less.

1   55. The method of claim 24, wherein the contacting step is carried out at a temperature of

2   about 325°C or less.

1   56. The method of claim 24, wherein the contacting step is carried out at a temperature of

2   about 300°C or less.

1   57. The method of claim 24, wherein said catalyst is not supported on a carrier.

1   58. The method of claim 24, wherein said catalyst is supported on a carrier selected from

2   the group consisting of silica, alumina, titania, zirconia, magnesia, zeolites, clays and

3   combinations thereof.

1   59. The method of claim 24 wherein said contacting is carried out for a time in the range

2   of from about 100 milliseconds to about 10 seconds.

1   60. The method of claim 24, wherein said gas mixture comprises oxygen in the range of

2   from about 0.01-20% by volume and ethane in the range of from about 10-99.99% by volume.

1   61. The method of claim 60, wherein said gas mixture further comprises diluents in the

2   range of from about 0.01-60% by volume.

1   62. The method of claim 60, wherein said reaction pressure is in the range of from 0.5 to

2   20 bar.

1   63. The method of claim 24, wherein said catalyst is diluted with a binder or inert filler.

1   64. The method of claim 24 wherein said catalyst is calcined at a temperature of 400°C or

2   less.

1   65. The method of claim 24 wherein said catalyst is calcined at a temperature of 350°C or

2 less.

1   66. The method of claim 24 wherein said catalyst is calcined at a temperature of 300°C or

2 less.

67. A method for the oxidative dehydrogenation of ethane to ethylene, optionally with

ethylene as a co-feed with said ethane, comprising contacting ethane to a catalyst comprising

3 nickel oxide (NiO) with either niobium oxide (Nb_2O_5) or tantalum oxide (Ta_2O_5).